UNIT 4
Part 2
Measurements of Environmental Air Pollution Parameters

UNIT-IV Acoustic Measurement and Optical Fiber Sensors

Microphones, Capacitor type microphone, Piezo-electric crystal type microphone, Electrodynamic type microphone, Carbon microphone, Measurements of environmental air pollution parameters, Orsat apparatus for exhaust gas analysis, Gas chromatography, Non—dispersive infrared gas analyzer, Smoke density measurements, Optical Fiber Sensors, Advantages of Optical Fiber Sensors, Types of Optical Fiber Sensors, Biosensors, Smart Sensors

Environmental Air Pollution

- The addition of any harmful material (having harmful effects on our lives) to our atmosphere is called as the *Environmental Pollution*

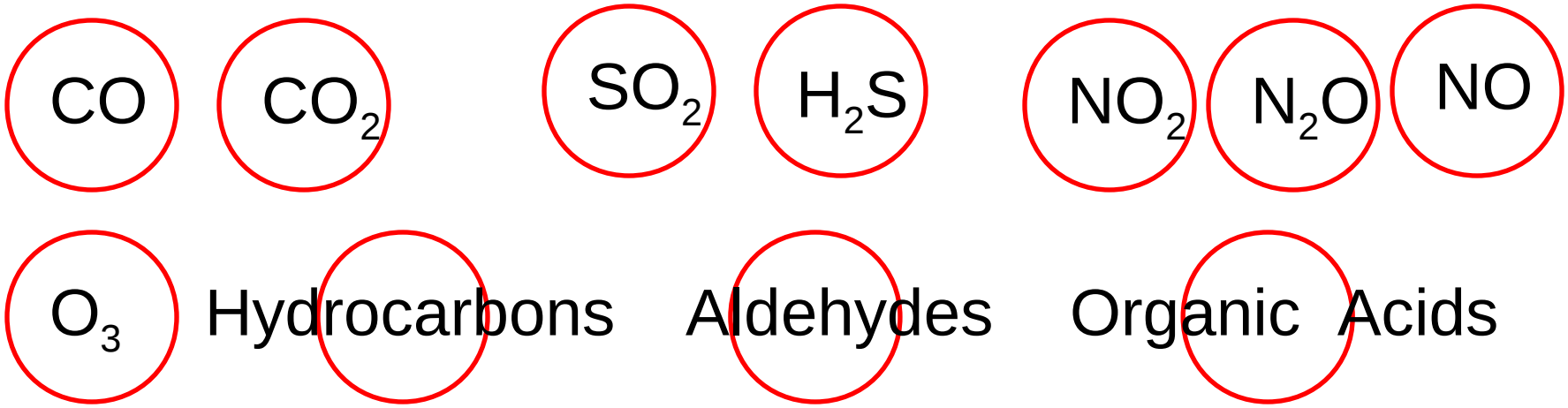









Environmental Air Pollution



- Vapors of water and other solvents present in smoke;
- Aerosols like iorganic sulfates,nitrates,chloride and ammonium salts.
- Small solid particles like atm dust, coal dust, fly ash, insecticide dust, pollen, metallic foundry dust, milled flour etc.

Environmental Air Pollution

- Primary Pollutant:
  High concentration, lethal in nature
- Secondary Pollutant:
  Low concentration, originates from reaction of primary pollutants, at origin or remote location.

- Air Pollution: Exhaust Emission;
  Process Inductries, vehicles, thermal power stations, domestic, forest & agriculture fires

- CO: heart desease;
- SO_2,NO,NO_2 irritant to breathing, eye burning
- O_3: headache.

Environmental Air Pollution

- Quality of Pollutant:

ppm =0.0001% by volume

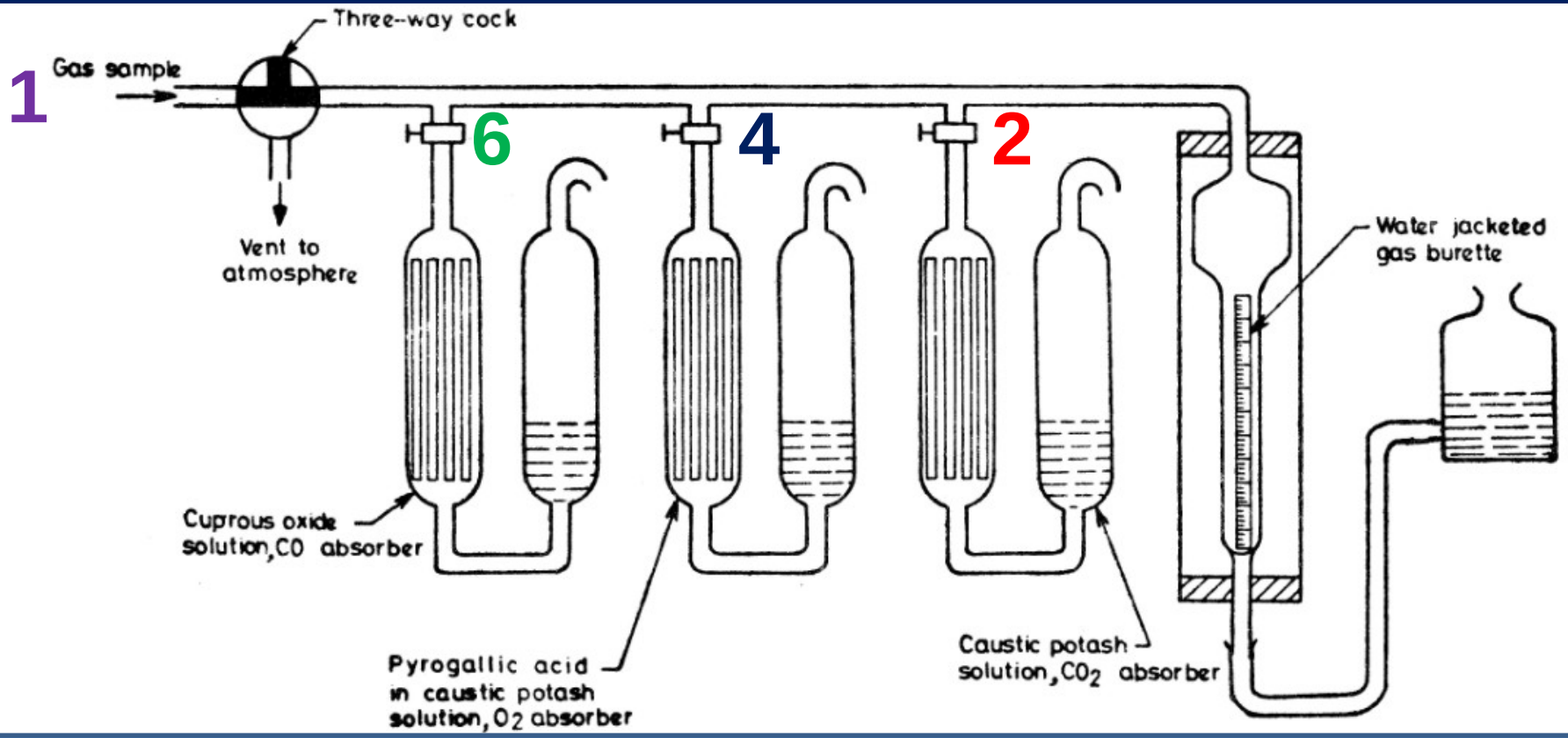
$$1\ \text{ppm} = \frac{1\ \text{volume of gaseous pollutant}}{10^6\ \text{volumes of air (containing pollutants)}}$$

$$= 0.0001\ \text{per cent by volume}$$

Orsat Apparatus for Exhaust Gas Analysis

- Simple & Commonly used Lab Device.
- Analysis of product of Combusion.
- % of CO_2, O_2 , CO and N_2.

Orsat Apparatus for Exhaust Gas Analysis

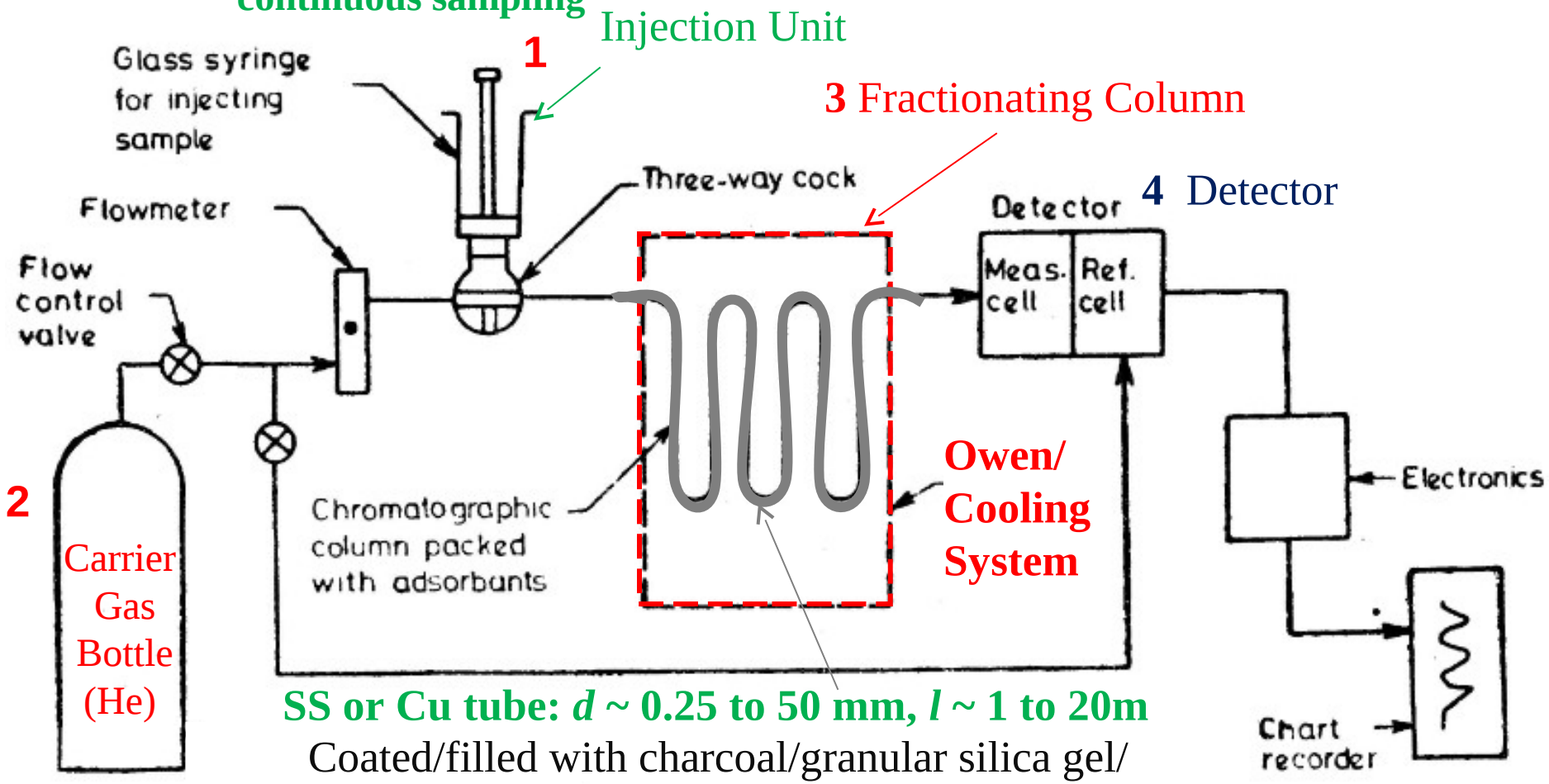


$$M_D = 0.44\,(\%\text{ of } CO_2) + 0.25\,(\%\text{ of } CO) + 0.32\,(\%\text{ of } O_2) + 0.28\,(\%\text{ of } N_2)$$

where M_D = dry molecular weight of the sampled gas

Block Diagram of Gas Chromatograph

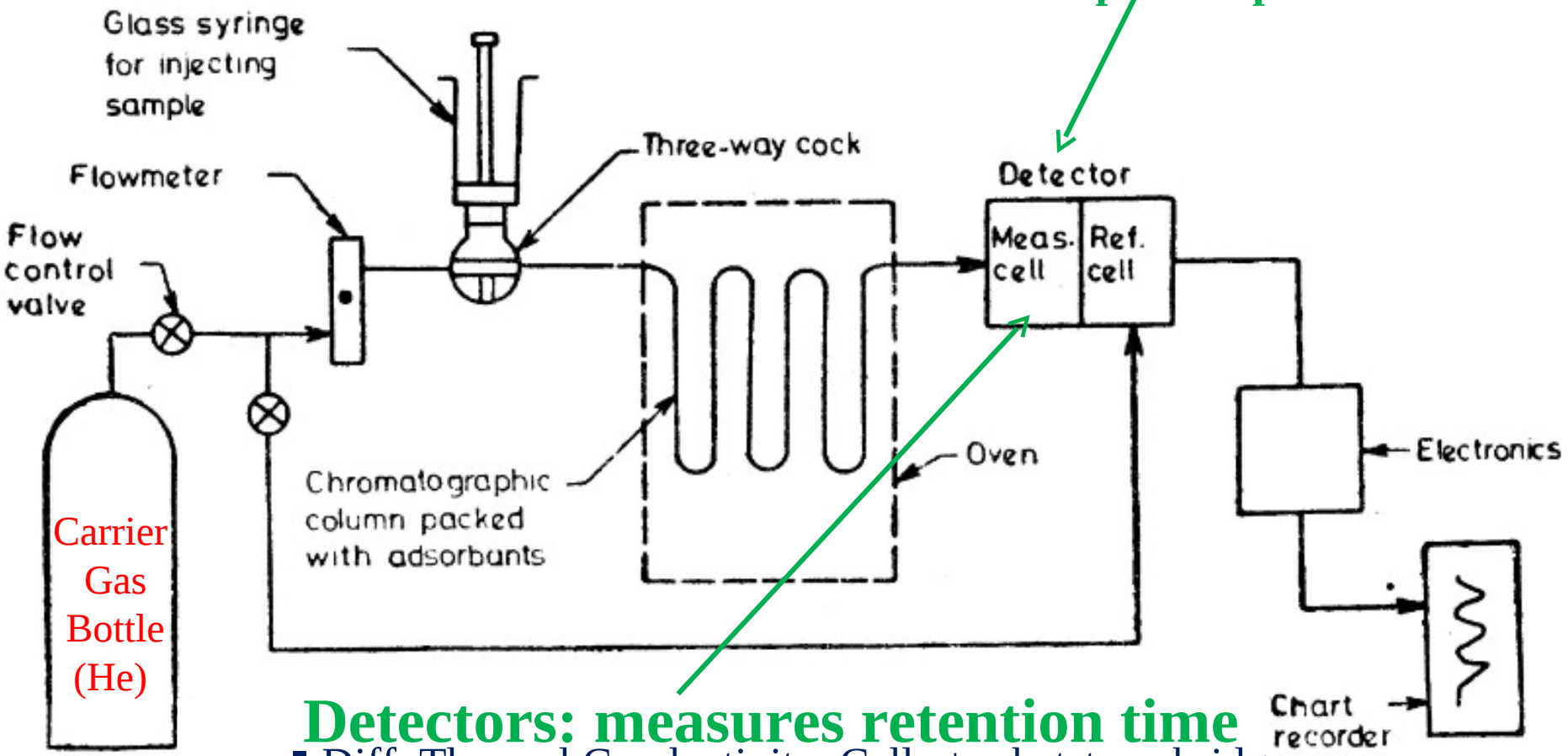
- **continuous sampling**



SS or Cu tube: d ~ 0.25 to 50 mm, l ~ 1 to 20m

Coated/filled with charcoal/granular silica gel/ activated alumina/suitable liquid

Block Diagram of Gas Chromatograph



Detectors: measures retention time

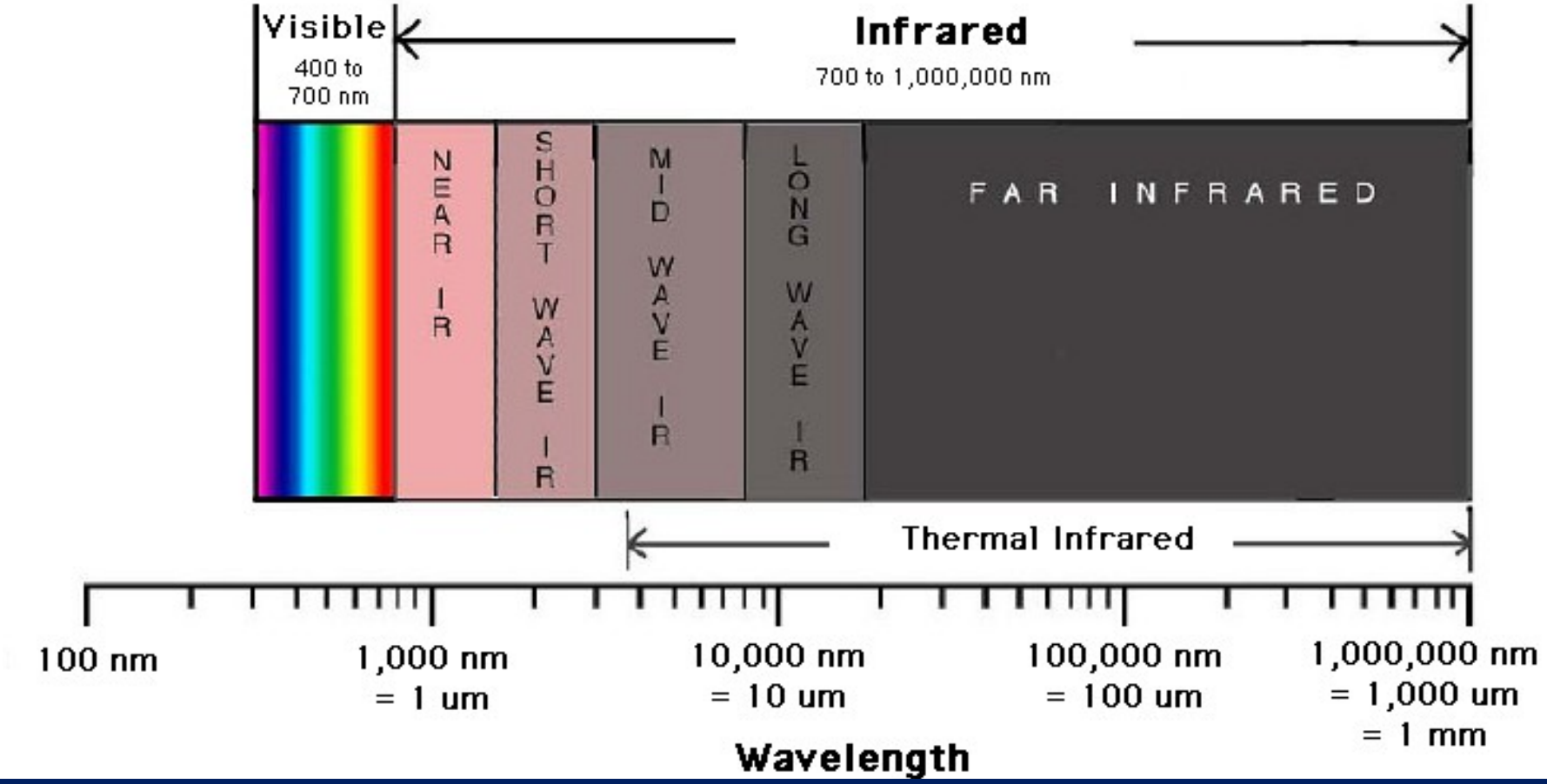
- Diff. Thermal Conductivity Cells + whetstone bridge
- Cooling Effect of Gas flowing over a heated filament.
- Hydrogen Flame ionization/ Ar ionization detectors

etc..

Non-dispersive Infra-Red Gas Analyzer

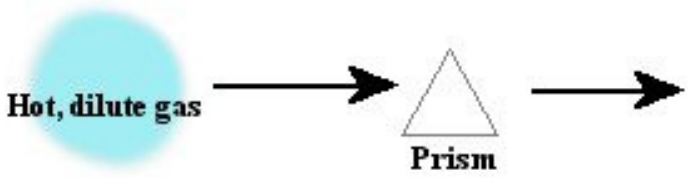
also known as

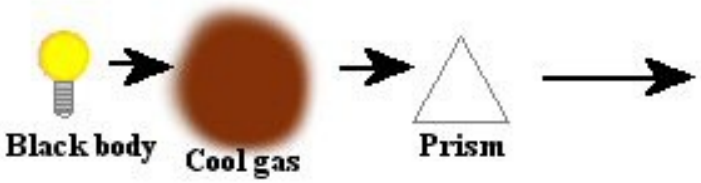
Infra-Red Absorption Spectrometer



Infra-Red Radiations

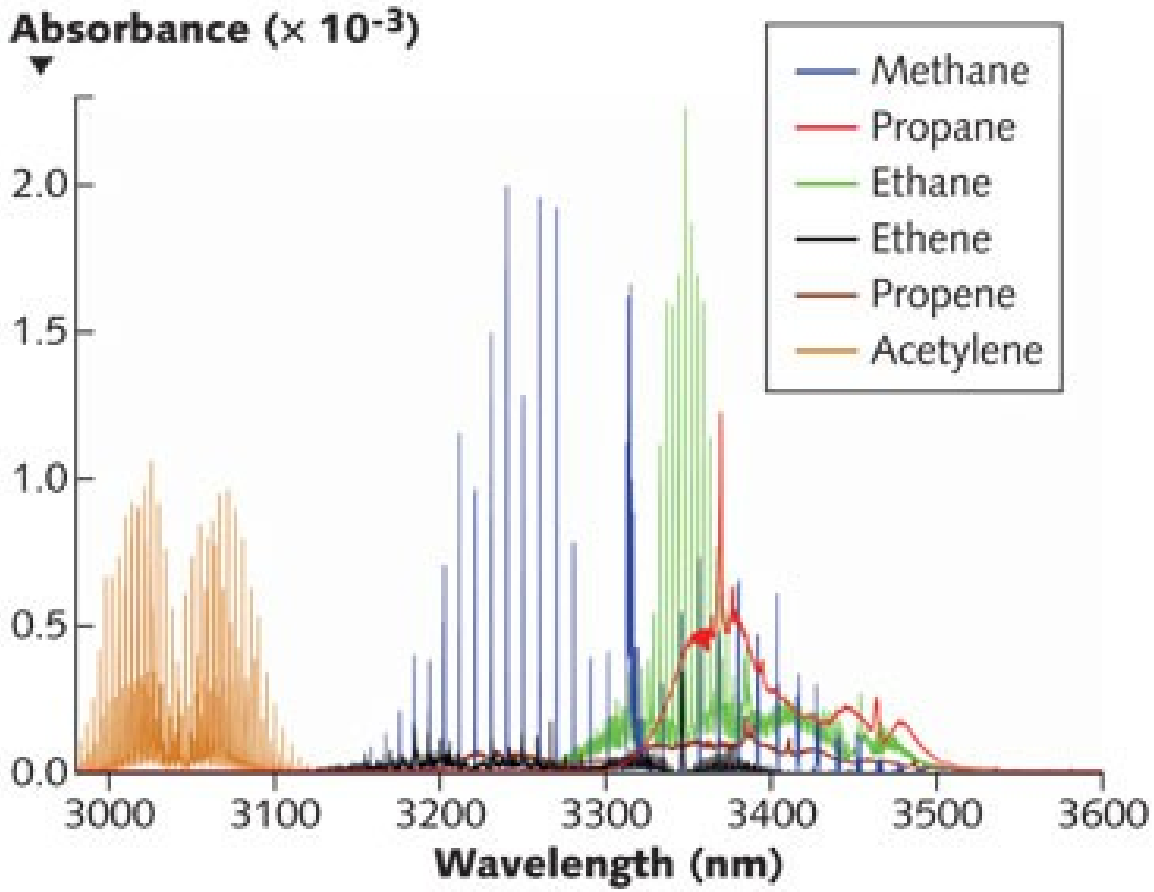
Radiation Spectra





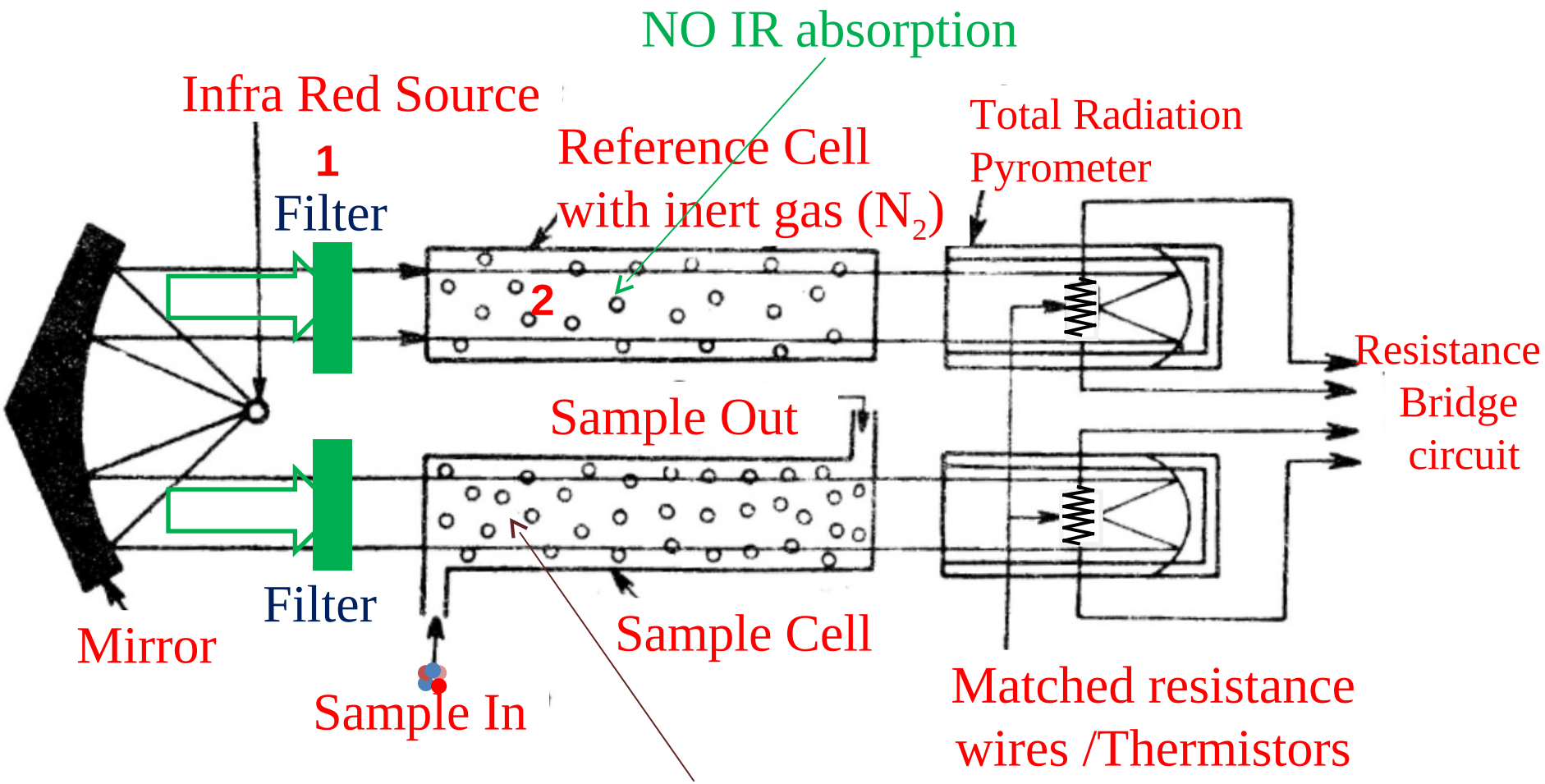
Non-dispersive Infra-Red Gas Analyzer

- To determine concentration of gaseous pollutants in a sample.
- Principle: ***Absorption of IR radiations in narrow wavelength bands with each gas exhibiting its own peculiar characteristics.***
- e.g. each hydrocarbon has its own characteristic absorption spectrum.



Infra-Red Absorption spectra of hydrocarbons

Non-dispersive Infra-Red Gas Analyzer



IR absorption proportional to no. of molecules per unit volume

Non-dispersive Infra-Red Gas Analyzer

Beer's law:

$$C = \frac{1}{ax} \log (I_0/I_x)$$

C = concentration of substance
a = absorption factor of substance
x = thickness of sample (along the optical path)
I_0 = intensity of beam before sample
I_x = intensity of beam after sample.

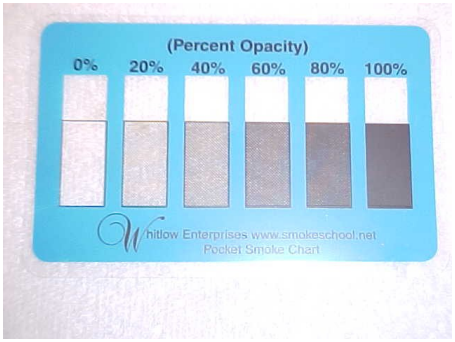
- Useful for qualitative and quantitative determination of organic gases and liquids.
- Higher minimum sensitivity than chromatograph.
- O_2, N_2, H_2, Cl_2, other diatomic gases and inert gases do not absorb IR radiation.

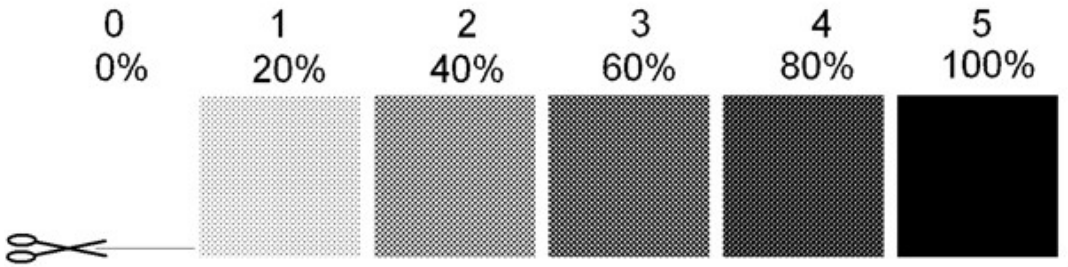
Smoke Density Measurements

Smog: vapors+aerosols+dust+bacteria

Decrease in Visibility

Smoke Density Measurements; Ringleman Scale: Opacity Comparision





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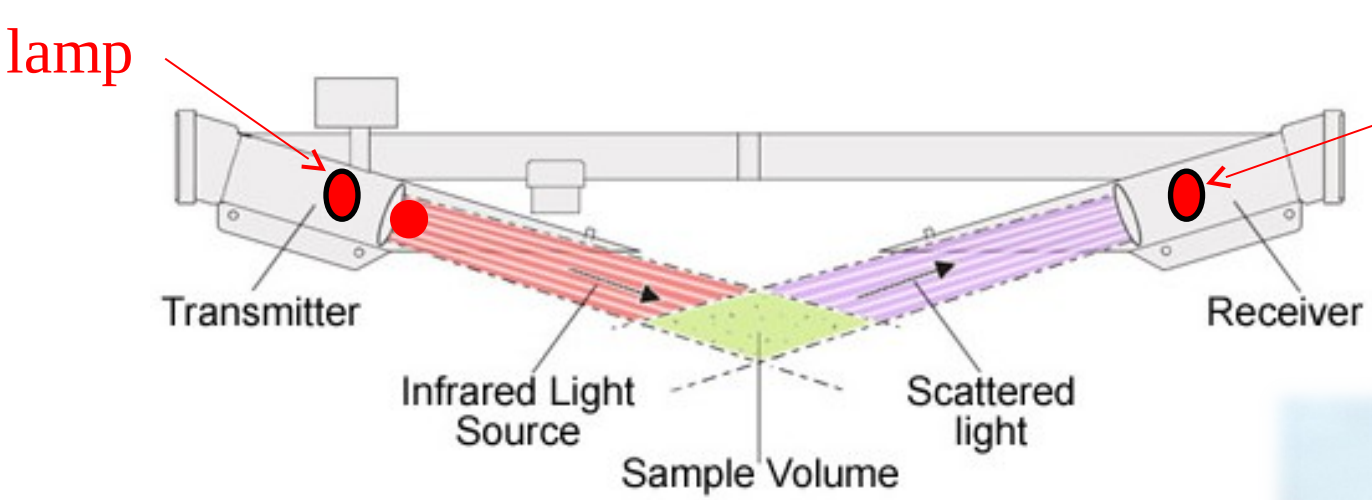
- Six Ringlem
- Not useful f
- Experience number.

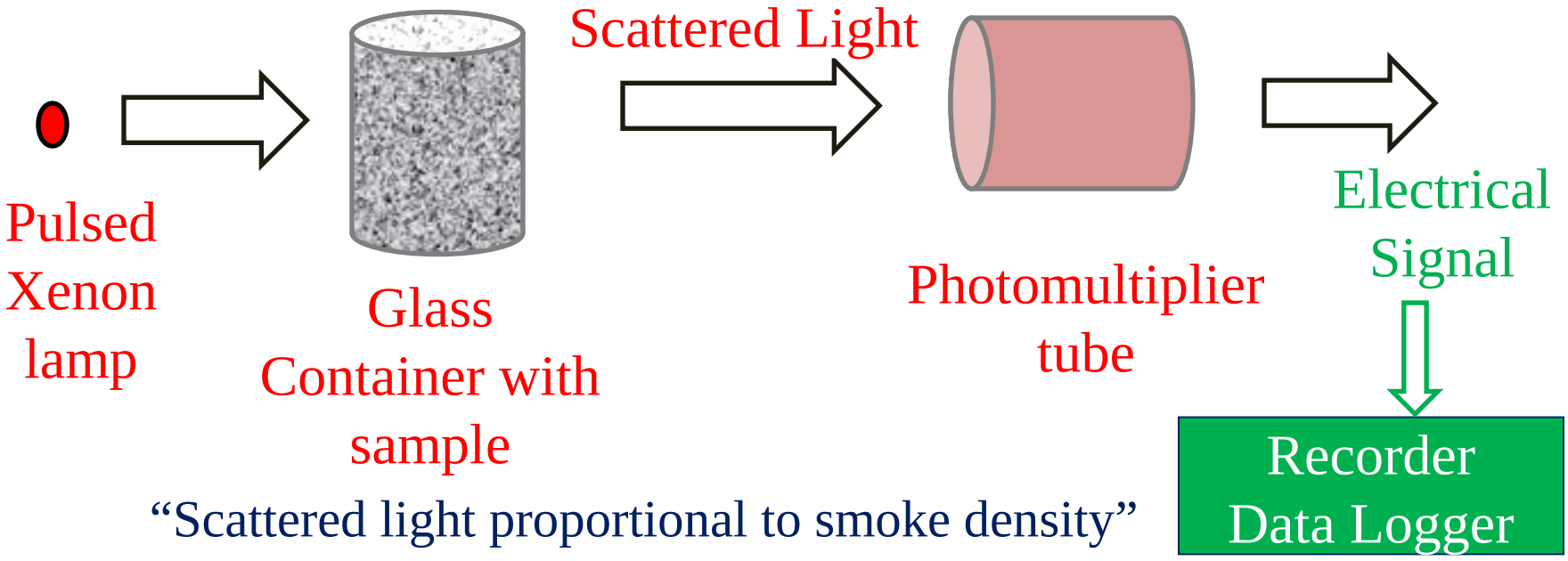
Smoke Density Measurements; Visio meter Type-1



Forward Scater Visiometer

- For Large Plants.
- Continuous Sampling.
- Intensity comparison

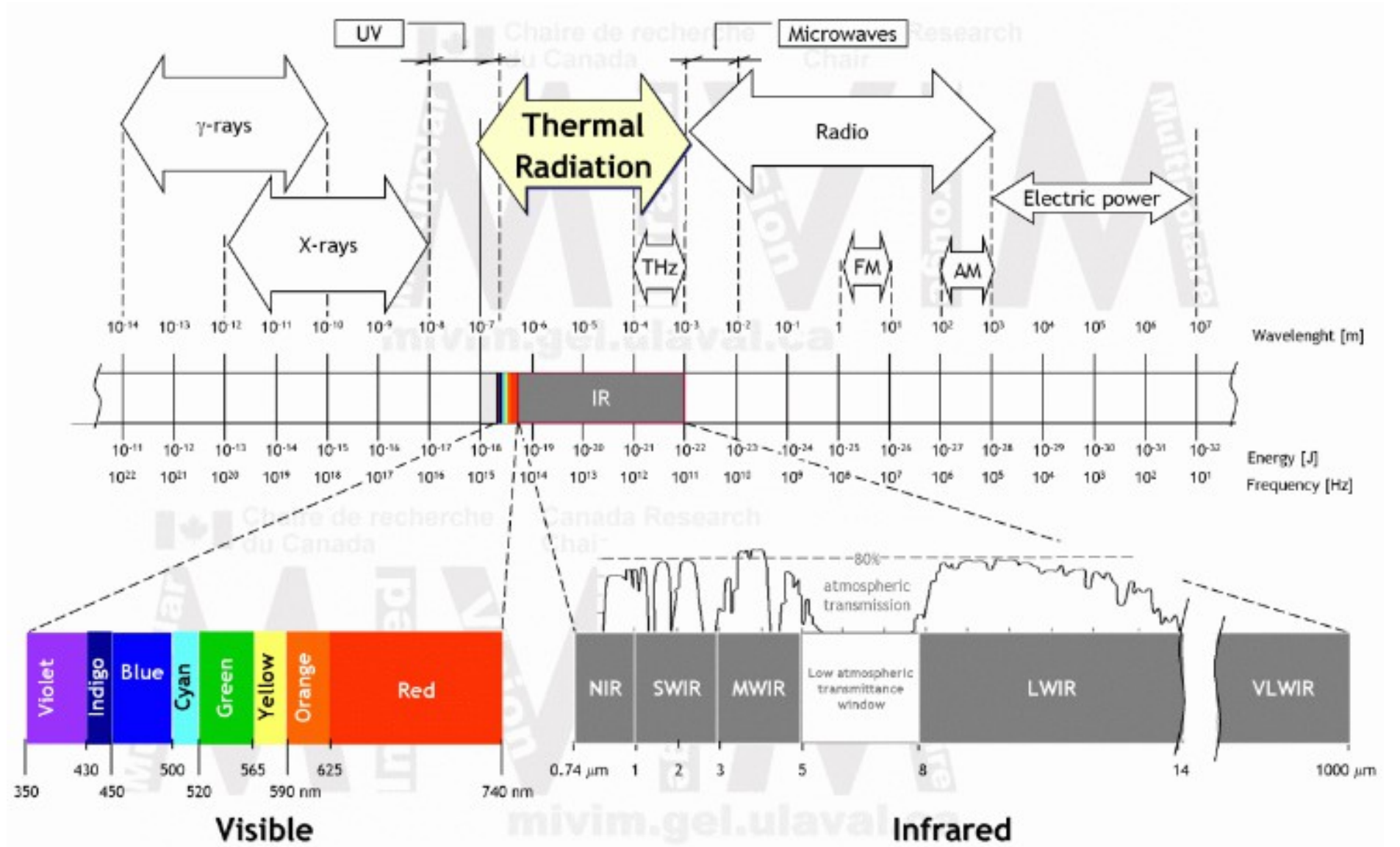
Smoke Density Measurements; Visio meter Type-2



"Scattered light proportional to smoke density"

- *Alarm System can be operated.*

Non-dispersive Infra-Red Gas Analyzer



Infra-Red Radiations